Nutrient management is also quite important. An appreciable decrease in drainage volume (annual and wet season) can effect sizeable reductions in nutrient loads; nonetheless, home and farm fertilization practices should also be evaluated. For example, the amount and type of phosphorus application on citrus groves can be investigated with an aim toward recommending fertilization practices that can reduce runoff phosphorus concentrations without compromising crop production or cost[20].

Developing a comprehensive IRFWCD water management plan is proving to be an immense challenge. The plan must balance competing needs -- the restoration needs of the Lagoon and the drainage needs of a developing community. Furthermore, this plan may incorporate a water supply element. Construction plans for an electrical power plant in Vero Beach are being prepared. The plant's need for cooling water could be primarily satisfied by taking water from the IRFWCD canals. Withdrawals of canal water to satisfy this demand could help reduce drainage to the IRL. Even though the feasibility of this water supply option is not known yet, an opportunity like this is compelling because of its potential to be mutually beneficial to various water resource interests.

As the planning team nears consensus on a conceptual plan, other agencies such as USACE, FDEP, Florida Department of Agriculture and Consumer Services, and possibly the National Resources and Conservation Service will certainly be drawn in to review and comment on the plan, and hopefully participate. Cost-share funding from as many entities as possible will be critical to the success of the project. In 2000, the state legislature jump-started the project when it appropriated seed monies (~$4 million) toward the planning effort and for the eventual construction of some of the to-be-designed structural solutions.

Non-point Source Strategy – Muck. The 1989/90 IRL muck sediment survey revealed that only 10% of the Lagoon bottom area, from Ponce de Leon Inlet to St. Lucie Inlet, is covered with muck (Trefry et al. 1990). That is the good news. However, its distribution is the bad news. Most of the muck, over 65% of the cumulative area of muck, is deposited in the Central IRL (which is only 27% of the total length of the IRL system). It's a recent phenomenon too; nearly all the muck in the IRL has been deposited in just the last 40 years (Trefry et al., 1990).

Lagoon muck mostly consists of upland soils, clays and silts, with a lesser but generous amount of organic material. These eroded soils and organic debris are washed into drains, ditches, canals, and creeks and end up primarily in tributary creek mouths, the Intracoastal Waterway, causeway borrow pits in the Lagoon bottom, and other dredged or natural holes (Figure 5-11). As mentioned in previous chapters, muck sediment is a concern because of its deleterious effects on water quality and seagrasses. Muck can easily be re-suspended, increasing turbidity in the water and limiting light to seagrasses. Muck releases significant loads of nitrogen to the water[21], contributing to algae growth, which exacerbates turbidity levels. And, muck has a high oxygen demand, contributing to oxygen depletion in the water column.

[20] A study is underway now to demonstrate the benefits of fertigation and to investigate alternative, slow-release, fertilizer media that can help reduce phosphorus-laden runoff from citrus groves. This study is being conducted by the IFAS, Indian River Research and Education Center, Ft. Pierce.

[21] For example, in the Central IRL, the N loading from muck sediment (~4 million lb/yr N) is twice that of surface water N loading (derived from Trefry et al.,1992 ; Reddy et al., 1999; SJRWMD unpublished data).

The strategy to deal with muck is two-fold: muck removal coupled with upland source control. This strategy is being pursued within areas where muck is believed to be an important source of nitrogen and/or turbidity. Both the North and Central IRL contain candidate sites for muck removal but the Central IRL certainly contains a greater number of large and extensive muck deposits. Therefore, most of the effort and funding spent by the SJRWMD, the state, and local cooperators have been and will continue to be directed toward the Central IRL.

The Intracoastal Waterway (ICW) is a prime candidate for muck removal. The ICW channel, because of its 12 to 15 ft maintenance depth, functions as a sump for the fine-grain muck sediment. A significant volume (>70%) of the muck that reaches the Lagoon proper ends up in the ICW channel. The USACE and the Florida Inland Navigation District (FIND) are responsible for maintenance dredging the ICW and for managing ICW dredge material disposal sites, respectively. These two agencies are committed to accelerating the ICW dredge schedule contingent upon an equal commitment by Congress to appropriate sufficient funds to support the schedule. In 1996, the USACE and FIND proposed an accelerated 10-year dredge plan, called the "Environmental Dredging Program," for the Mosquito Lagoon and the North and Central IRL. Part of that plan is presently underway for the ICW reach that extends from south Mosquito Lagoon through North IRL to Titusville. The dredge schedule for the ICW reaches south of Titusville and into the Central IRL has been postponed because the necessary federal appropriations have not been forthcoming.

In addition to the ICW, other potential sites for muck removal in the Lagoon proper include the lesser navigation channels and turning basins, causeway borrow pits and other dredged holes. The SJRWMD identified six major areas in the North and Central IRL that contain numerous and/or extensive muck-filled sites. Three of the areas are located in the Titusville and Cocoa vicinities of the North IRL. The remaining, more muck-laden areas are located in the Central IRL: the South Tropical Trail area south of Rockledge, a 10-mile zone between the S.R. 518 (Eau Gallie) causeway and Turkey Creek, and the Vero Beach area. No dredge work is scheduled yet within these areas, but planning discussions with prospective cooperators (USACE, FIND, cities, counties) are taking place.

Tributary creeks, collectively, is a third category of muck removal areas. The SJRWMD and several cooperators are actively engaged in muck dredge planning or construction in several of the tributaries in the Central IRL: Eau Gallie River, Crane Creek, Turkey Creek, and Sebastian River. Thousands of metric tons of muck (upland soils and organic matter) are conveyed through these tributaries yearly. For decades, the lower reaches of these creeks have served as traps, retaining a large amount of this material and saving the IRL from the full burden. The creek "traps" have been quickly filling in (e.g., muck depths exceed 10 ft in Crane Creek and 15 ft in Turkey Creek), and muck migration rates to the IRL may increase as a consequence.

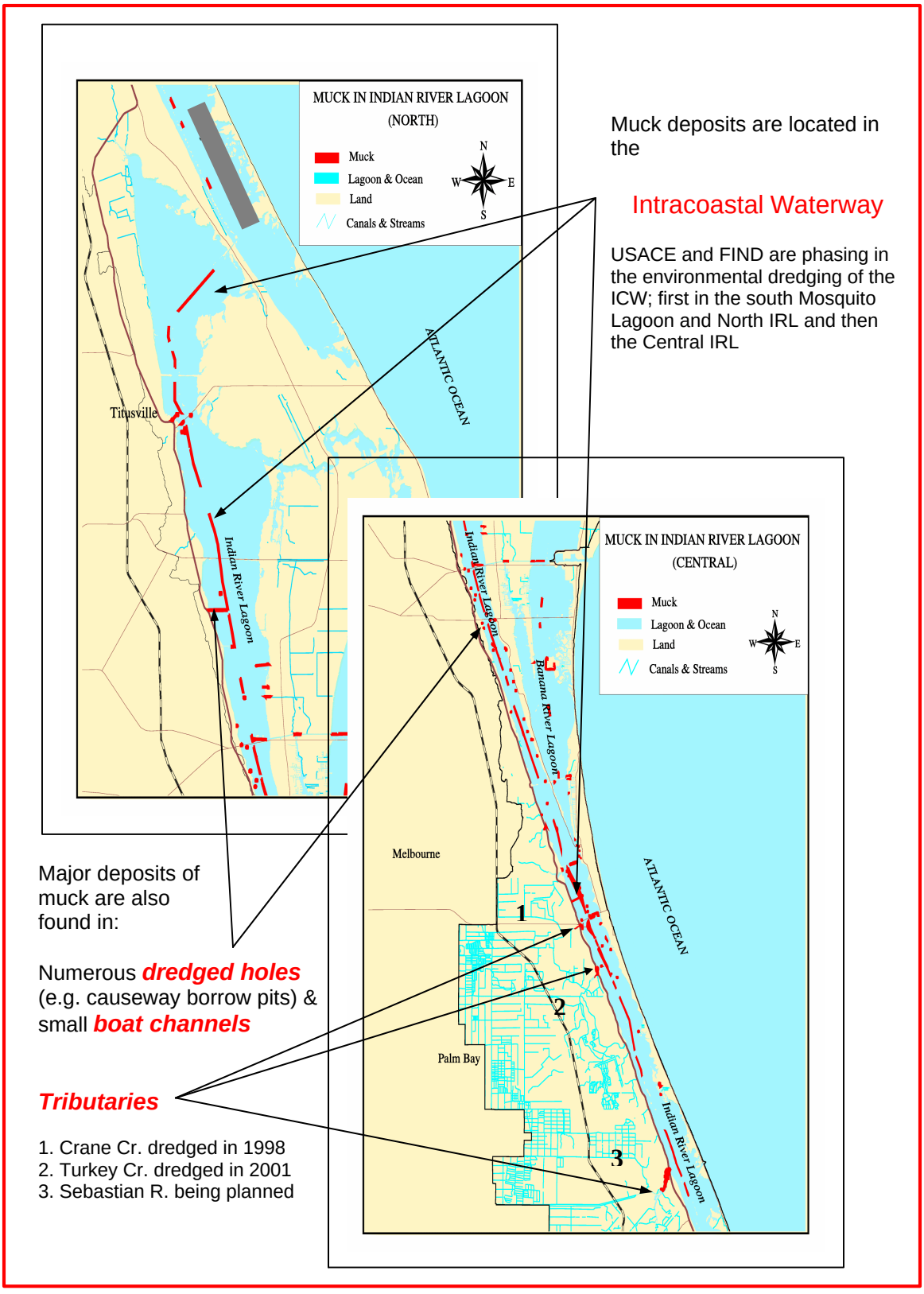

Figure 5-11. Muck sediment distribution in the North and Central IRL.
Compared to the other IRL sub-lagoon areas, the Central IRL contains the largest percentage of muck by depositional area (>65%) and possibly by volume.

Management actions involve controlling the upland sources of muck sediment prior to, or in concert with, cleaning out and restoring the storage capacity of the creek "traps."

The lower reach of Crane Creek was dredged in1998 (~95,000 cu yd) and a larger muck removal project was completed in Turkey Creek in May 2001 (~380,000 cu yd). Detailed plans and permits are being prepared for a muck removal project in Sebastian River, and a conceptual dredge and disposal plan was developed for Eau Gallie River.

A post-dredge evaluation of Crane Creek is presently underway to determine whether the dredge operation satisfied environmental objectives or expectations of a muck removal project. This is a 3-year investigation, and full results will be reported in 2003. A similar investigation is being planned for Turkey Creek, but funding support for the project is uncertain. Even though it is still early in the Crane Creek investigation, data on post-dredge sedimentation rates do indicate the importance of implementing effective erosion or source controls prior to or concurrent with tributary muck removal. Periodic maintenance dredging of the creek "trap" should also be considered.

Disposal of dredged muck material is another challenge. Fortunately, nearly all the muck deposits surveyed are not considered contaminated or hazardous[22]. In fact, given that it's composed of upland soil enriched with nutritive organic material, muck should be regarded a beneficial resource to be used, not discarded as spoil. An investigation has shown a positive response of Bermuda grass and other landscape plants grown in IRL muck (BCI, 1996; BCI, 2000). It has been demonstrated that muck has potential as a topsoil amendment for nurseries, golf courses, roadway medians, and other green spaces. Melbourne-Tillman Water Control District (MTWCD) accepted truckloads of muck from Turkey Creek and spread it along canal banks and right-of-ways to encourage grass growth as a means to control side-bank erosion. Also, several agencies[23] have taken advantage of the dredged sand and shell, a by-product of the muck dredging, at their various public project sites as landscaping and fill material.

Non-point Source Strategy – Septic Tanks (a.k.a. OSDS). During the initial 5 years of the SWIM program, the SJRWMD contracted with Volusia, Brevard, and Indian River counties to conduct inspections of septic tanks or OSDS (on-site disposal systems) in areas that were known to have documented failures, and to survey areas served by OSDS to determine their potential to contaminate surface waters (as mandated by Chapter 90-262, Laws of Florida, a.k.a. IRL Act). The inspections lead to corrections of OSDS, and the counties completed the basin-wide surveys of OSDS areas (Brevard County – White and Wiggins, 1995; Indian River County – Indian River County Public Health Unit, 1992; Volusia County – Bielby, 1993).

The surveys concluded that the IRL basin is generally not suitable for OSDS, particularly at densities of two or more units per acre. OSDS may be acceptable in relatively small areas in the basin; for example, in the sand ridge areas or in areas with good soil infiltration capacities that are sufficiently distant from surface waters. The surveys further delineated OSDS areas that pose a surface water contamination threat (as a result of poor soil permeability, shallow water table, high OSDS unit density, or other

[22] It's suspected that muck deposits within Port Canaveral and Manatee Pocket (in the St. Lucie R. watershed) may be regarded as contaminated with respect to certain metals or organic compounds, but appropriate analyses have not been performed to confirm this.

[23] Melbourne Tillman Water Control District, Brevard County, Town of Malabar, and the City of Palm Bay.

factors). Some of the potential problem areas identified in the North and Central IRL include Port St. John, Palm Bay, southern Brevard County, Sebastian (especially Sebastian Highlands residential area), and southeastern Indian River County.

Some of these same areas were the subject of further investigations in an effort to determine the role of OSDS in the enrichment of groundwater nitrogen levels and loading to the IRL. The investigators concluded that "…virtually all of the effluent from these OSDS … end up in the lagoon" (Horsley and Witten, Inc., 2000). In the same study, it was found that OSDS effluent elevates water table concentrations of nitrogen to approximately 15 times above background levels. Given these findings, it is quite conceivable that OSDS areas may have a localized impact on water quality in certain segments in the IRL basin (e.g., IR6 – 11, IR13, Sebastian River, and IR20; refer to Figure 5-1 for location of segments).

A reduction in OSDS use in Brevard and Indian River counties is strongly encouraged by the SWIM initiative; not only for the sake of the IRL system, but also for the protection of groundwater quality and the reduction of public health risks associated with the potential release of pathogens to either ground or surface waters. Some local governments such as the City of Palm Bay and Indian River County are gradually eliminating OSDS use in favor of centralized wastewater treatment service.

The primary obstacles in resolving the OSDS problem are (1) lack of public funds to expand centralized wastewater treatment plant (WWTP) service, and (2) rules or policies that allow new OSDS installations in areas that are not well suited for OSDS. OSDS often offer the least expensive and most expedient means of treating domestic wastewater. It's difficult for local governments and citizens to bear most of the cost of connecting homes to a WWTP. A homeowner may be expected to pay thousands of dollars in fees to connect to a WWTP and for the proper abandonment of their OSDS units. Furthermore, there is no substantial financial support offered by federal or state agencies. It is unlikely this problem will be fully or rapidly remedied unless there is a significant financial commitment by the state and/or federal government to support the necessary infrastructure construction and home "hook-ups."

Point Source Strategy – Domestic Wastewater Treatment Plants. In the North and Central IRL, the cities and counties have achieved remarkable reductions in pollutant loading from domestic wastewater treatment plants (WWTPs). Consequently, domestic WWTPs appear to be a very minor source of pollution thanks to local government action in response to the IRL Act (formerly named the IRL "No Discharge" Act in the 1994 SWIM Plan; Chapter 90-262, Laws of Florida). WWTP loadings of nitrogen and phosphorus have decreased by well over an order of magnitude since 1986 (SJRWMD and SFWMD, 1987). Today, WWTP contributions of TN (30,375 lb/yr), TP (3,550 lb/yr), and TSS (3,941 lb/yr) represent 0.2 to 1.4% of the total surface water loading of these constituents to the North and Central IRL (Figures 5-8 and 5-9).

The Central IRL continues to stand out as contributing the highest WWTP loadings among the major sub-lagoons (up to 22% of the total for Mosquito, Banana, and the entire Indian River proper), which is certainly a reflection of the high and increasing levels of residential development in south Brevard and Indian River counties. Even so, WWTP loadings of TP, TN, and TSS in the Central IRL pale in comparison to their non-point loadings (Figure 5-9).

Monitoring, Modeling, and Applied Studies. Aided by volunteers from several agencies, the SJRWMD has maintained and improved the seagrass and water quality monitoring networks in the North and Central IRL (see network description in Chapter 2, pp. 15-16). The SJRWMD refined the monitoring networks to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass (Sigua et al., 1996); and will periodically assess the need for further refinements. SJRWMD's analyses and reporting of monitoring data is largely restricted to seagrass coverage and those major optical pollutants germane to the seagrass-light limitation problem.

Data collected during 1997 through 1999 from both the water quality and seagrass monitoring networks were invaluable in the calibration of the Pollutant Load Reduction (PLR) Model. The PLR Model will be applied toward the development of *final* PLRGs[24]. In the meantime, *provisional* PLRGs, expressed as allowable loading rates based on 1943 land use, have been developed[25] for the segments in the North and Central IRL (Tables 5-4 and 5-5). Provisional PLRGs are considered conservative planning targets that can be used in watershed planning and non-point source treatment design. Provisional PLRGs could be adopted as final but the PLR Model will be used to help ascertain whether these provisional targets are reasonable or too stringent or impractical (and thus be revised).

Over the last 4 years, other models were developed that quantify the salinity response to a full range of freshwater discharges from the Turkey Creek/MTWCD and Sebastian River systems (Sucsy and Morris, 1998; Sucsy et al., 1997). These models enhance the District's capability to evaluate different water management alternatives for their effects on salinity zones within those estuarine systems. For example, the Turkey Creek salinity model confirmed an earlier study that set maximum discharge criteria for MTWCD's C-1 canal (Steward and Higman, 1989); and enabled the establishment of minimum discharge criteria to protect the creek's freshwater habitats. These models are used to assess salinity gradient changes that may occur due to the deepening of stream bottoms as a consequence of muck removal. Freshwater discharge criteria can then be re-evaluated to ensure compliance with salinity targets.

Fine-tuning hydrologic, salinity, and water quality models is and has been emphasized over the last 2 years as recent data are collected or environmental processes are better understood and quantified. This refinement is intended to produce more accurate appraisals of freshwater and pollutant load impacts and; therefore, more credible, defensible PLRGs and freshwater discharge criteria. Numerical models will also be utilized to evaluate the various management options to achieve PLRGs. Thus, it's imperative to have models that are calibrated and verified. Schedules for completion and application of the PLR Model and other sub-basin models are described in the foregoing section, *The Next 5 Years*.

[24] PLRGs are pollutant load reduction goals, which are numeric targets established for the reduction of anthropogenic loads of pollutants that pose a stress on seagrasses.

[25] Provisional PLRGs were developed using an inference method that relies on a simple, mass-balance algorithm known as the Pollutant Load Screening Model (Adamus and Bergman, 1995). This model incorporates land uses, soil types, rainfall-runoff coefficients, and regional average pollutant concentrations to calculate annual pollutant loads.

Table 5-4. Provisional "allowable" loading rates for TN, TP, and TSS in North Indian River Lagoon based on estimated 1943 land use loading rates [calculated from Pollutant Load Screening Model (Adamus & Bergman, 1995) modified for the IRL Basin]

North IRL Segments *(from north to south)**	***TN*** *lb/ac/yr (total lb/yr)*	***TP*** *lb/ac/yr (total lb/yr)*	***TSS*** *lb/ac/yr (total lb/yr)*
IR1-3	2.6 (138,500)	0.30 (15,800)	38 (2,054,000)
IR4	4.3 (11,000)	0.68 (1,725)	72 (183,000)
IR5	3.0 (101,500)	0.24 (8,100)	43 (1,440,000)
IR6-7	3.9 (83,300)	0.46 (10,000)	50 (1,076,000)
IR8	5.6 (14,100)	1.0 (2,500)	89 (235,000)

* Refer to Figures 5-1 and 5-2 for location of segments.

Table 5-5. Provisional "allowable" loading rates for TN, TP, and TSS in Central Indian River Lagoon based on estimated 1943 land use loading rates [calculated from Pollutant Load Screening Model (Adamus and Bergman, 1995) modified for the IRL Basin]

Central IRL Segments *(from north to south)**	***TN*** *lb/ac/yr (total lb/yr)*	***TP*** *lb/ac/yr (total lb/yr)*	***TSS*** *lb/ac/yr (total lb/yr)*
IR9-11	4.1 (79,250)	0.32 (6,200)	50 (972,000)
IR12*	1.9 - 4.9**	0.2 – 0.6**	32 - 63**
IR13A	4.8 (8,650)	0.42 (753)	55 (99,100)
IR13B	4.9 (81,900)	0.35 (5,840)	59 (991,500)
IR14	5.1 (397,700)	0.44 (34,140)	58 (4,519,000)
IR15	4.9 (17,400)	0.82 (2,900)	68 (241,200)
IR16-20	5.2 (346,600)	0.66 (43,940)	74 (4,887,000)
IR21	2.2 (5,320)	0.33 (818)	41 (101,500)

* Refer to Figures 5-1 and 5-2 for location of segments.

** Segment IR12 includes Crane Creek and Turkey Creek sub-basins, which constitute the majority of that segment's watershed. Reduction targets for those sub-basins were established by criteria other than calculation by the Pollutant Load Screening Model. The target ranges above encompass the Turkey and Crane Creek's targets and the estimated 1943 loading rates for other areas within segment IR12.

Drift macroalgae (especially *Gracillaria* spp.) and the attached macroalga *Caulerpa prolifera* comprise a component of the IRL system that plays a large role in nutrient dynamics and as a habitat resource. However, their distribution and abundance throughout the IRL, especially that of drift macroalgae, are not adequately documented. Like the Banana River Lagoon, some segments of the IRL contain large masses of drift macroalgae, functioning as a nutrient "sponge", thereby limiting the availability of nutrients to phytoplankton. Phytoplankton (i.e., chlorophyll *a*) can effectively compete with seagrass for available light in the water column; that is, phytoplankton can become an optical pollutant. Some researchers believe that high macroalgae densities are an early symptom of nutrient enrichment or eutrophication, which could transition to a more chronic symptom of high phytoplankton levels or algal blooms (Bricker et al., 1999).

On the other hand, drift macroalgae provide habitat value comparable to that of seagrass, although macroalgae is more ephemeral than seagrass. Densities of animals on drift macroalgae and seagrass are similar, and about 75% of the species are common to both plant types. The habitat function of drift macroalgae is considered an extension of the seagrass habitat – often extending viable habitat beyond the deep edge of the seagrasses (Virnstein and Howard, 1987). Considering that drift macroalgal biomass in the IRL can average three times seagrass biomass, and is considerably more than that in some segments (SJRWMD unpublished data), the potential significance of this habitat warrants investigation.

The dual role of macroalgae as habitat and mediator of nutrient loads raises many questions. Are the macroalgae densities in some IRL segments considered too high, and is that an indication that nutrient levels may already be excessive? If macroalgae densities decrease appreciably even though nutrient loadings do not, will phytoplankton or algal blooms become more frequent? If nutrient reduction efforts reduce macroalgae abundance or coverage, has the IRL lost important habitat? Answering these questions may require specific modeling and regular macroalgae monitoring/mapping as part of the routine status assessment of the IRL.

Within the IRL program, BMP[26] efficiency monitoring and research has typically received relatively low funding support only because the construction or installation of BMPs is the primary programmatic focus. Once BMPs are in place then evaluations of their treatment levels can be performed with respect to meeting certain pollutant removal efficiencies or other specific standards. It is not practical to evaluate every BMP; rather representative or major BMPs will be chosen for such evaluations. Currently, the following BMP/remedial projects are being evaluated: Palm Bay's Basin 7 and Sebastian's Stonecrop basin drainage treatment systems, and the muck removal projects in Crane and Turkey Creeks. Although muck removal would not typically be viewed as a BMP, the periodic maintenance dredging of the creek "traps" could be regarded as such.

Land Acquisition. The acquisition of lands and buffer shorelines is a key strategy in the protection and restoration of wetlands and seagrasses in the North and Central IRL. This strategy is pursued largely through the IRL *Blueway* program. The *Blueway*

[26] **B**est **M**anagement **P**ractice. Refers to any structural solution or non-structural practice that controls, reduces or prevents pollution without substantive modification to existing land uses or drainage systems.

program, its scope and progress, is described in the section on Coastal Wetlands found in this and the other chapters.

In addition to acquiring lands that comprise critical habitats or habitat buffers, other lands are sought for constructing and operating surface water storage/treatment systems and dredged material (muck) management areas. Open lands, if sized correctly and appropriately located in the drainage basin, are the type of sites acquired for such purposes. The SJRWMD has been quite successful in its aggressive campaign to purchase lands within Turkey Creek/MTWCD, Sebastian River, and in other sub-basins that are required to proceed with water management, muck removal, or buffer preserve projects (Table 5-6). For example, since 1994 approximately 2,300 acres within the western portion of MTWCD were purchased for the C-1 re-diversion project and nearly 15,000 acres of the Sebastian River Buffer Preserve were jointly purchased by the SJRWMD and FDEP.

The acquisition campaign continues, but the financial challenge is becoming more difficult. State funds dedicated to land acquisition are dwindling. The SJRWMD will not be able to acquire lands on its own for much longer, thus making funding partnerships a practical necessity. In fact, SJRWMD always has preferred *joint* land purchases for water management projects. Typically, the acquisition partner is a local jurisdiction responsible for operating and maintaining the facility after its construction. Moreover, lands appropriate for large-scale, sub-basin projects are becoming increasingly limited and costly, especially in the Central IRL. Consequently, the determining land requirements for such projects (e.g., Crane Creek, Sebastian River, IRFWCD), and negotiating with the seller are on a "fast track."

Table 5-6. SJRWMD land acquisitions in North and Central IRL for buffer protection and water quality management purposes

Acquisitions – Parcel Name & Project Purpose	Acres
Corrigan (District/FDEP joint purchase) part of the ~23,000-acre Sebastian R. Buffer Preserve	6,894
Mary A (District/FDEP joint purchase) part of the Sebastian R. Buffer Preserve	1,482
Egan (District/FDEP) part of the Sebastian R. Buffer Preserve	1,167
Carson Platt (District/Indian R. County/FDEP) part of Sebastian R. Buffer Preserve	5,361
Curtis a.k.a. Ais Lookout Point (District, DOT, FCT) used to treat U.S. 1 drainage, Palm Bay	4.29
Platt, P. and T. (District) C-1 Re-diversion Project	210
Farm Credit of C. FL (District) C-1 Re-diversion Project	160
Tsamoutales (District) C-1 Re-diversion Project	19.25
G. Billie (District) C-1 Re-diversion project	10
Lapidus (District) C-1 Re-diversion project	10
Willard Palmer (District) C-1 Re-diversion project	205
Judge Platt (District) C-1 Re-diversion project	1,080
Carlyle Platt (District) C-1 Re-diversion project	585
Pine Island, Merritt Island (District/Brevard) Stormwater management & wetland preserve	769
Pine Island out-parcel (District/Brevard) Stormwater management & wetland preserve	98
Adams (District) drainage treatment facility for City of Sebastian	150
Wheeler Groves (District) Sebastian R. dredge material mgmt &/or stormwater treatment	286
Met Life (District) intended for Sebastian R. dredge material mgmt. and stormwater treatment	210
Inlet Groves (District/Brevard) wetland/upland preservation and restoration	290
Total acreage acquired to date (April 2002)	**18,990**

Coordination with Other Agency Plans. Non-point source pollution is the major problem in the North and Central IRL. The Central IRL, more than any of the other sub-lagoons in the SJRWMD, is in critical need of water quality remediation (via non-point source controls). This fact is fully recognized by the local governments, WCDs, and other agencies that manage land and water resources in Brevard and Indian River counties. Many of these agencies are coordinating their surface water planning with the SJRWMD to ensure consistency with regional strategies and policies regarding PLRGs, discharge criteria, and water quality in general. Most notably, the list of cooperating agencies include Titusville, Rockledge, Indialantic, Melbourne, Melbourne Beach, Palm Bay, Malabar, Sebastian, Vero Beach, Brevard and Indian River Counties, Melbourne-Tillman WCD, Sebastian R. WCD, Fellsmere WCD, Indian River Farms WCD, Florida Inland Navigation District (re: muck removal), FDEP Aquatic and Buffer Preserves, EPA, and NASA.

A few of the cities listed above have completed master plans and should be well-positioned to procure cooperative funding from the SJRWMD (including IRLNEP and its EPA funding source) and the FDEP/EPA Section 319 non-point source reduction grant program. Brevard and Indian River Counties are working with the SJRWMD and several other agencies (cities, aquatic preserves, WCDs, etc.) to comprehensively tackle various water quality and quantity issues in N. Merritt Island, Crane Creek, Sebastian River, and Indian River Farms WCD sub-basins.

NASA is consulting with SJRWMD on a full range of mitigation measures to offset future development impacts in the North IRL basin. These measures are intended to improve estuarine water quality (e.g., runoff containment/treatment) and wetland functions (e.g., impoundment reconnections, breaching, etc.). In addition, in 2001, SJRWMD and NASA established a formal arrangement to collaborate on a broad range of monitoring and data base management activities. Through this arrangement, NASA can dedicate specific resources to acquiring and managing a variety of environmental data (e.g., seagrass coverage, water and air quality data, meteorological data, etc.). This "centralization" of IRL data should benefit all public agencies managing natural resources in the IRL basin.

USACE and the SJRWMD recently drafted a scope of work for the IRL-North Feasibility Study. The study will address restoration alternatives in both the North and Central IRL. However, the Central IRL is the focus area with respect to evaluating surface water management and non-point source control projects alternatives such as muck dredging, watershed erosion control programs, surface water management BMPs, and possible causeway modifications to improve flushing and water quality.

The Next 5 Years

Strategies for Pollutant Load Reduction

Non-point Source Strategy – Surface Water Drainage. Volume reduction and treatment of surface water drainage will be key to the success of seagrass recovery in the IRL. This strategy is particularly the case in the Central IRL where regional planning efforts are underway and large capital expenditures are anticipated. Toward that end, the completing and implementing master surface water management plans are the main

5-year objectives common to the following priority sub-basins (and their local jurisdictional sponsors):

- **Crane Creek sub-basin** (can include the neighboring Eau Gallie River sub-basin; Brevard County, Melbourne, West Melbourne)
- **Turkey Creek sub-basin** (Melbourne-Tillman WCD, Palm Bay, Malabar)
- **Sebastian River sub-basin** (Sebastian, Sebastian R. WCD, Fellsmere WCD, Roseland, Indian River County)
- **Indian River Farms WCD** (including Vero Beach and Indian River County)

The SJRWMD supports these planning efforts with cost-share funding, with technical and planning staff participation, and by actively pursuing grant funds. The SJRWMD will continue such support through the implementation phase of these projects. By the end of the next 5 years, all the master plans listed above should be well into implementation. It is the SJRWMD's and local sponsors' mutual intent to develop the plans based on a set of PLRGs for total suspended solids, nitrogen, and phosphorus. Provisional PLRGs will be used on an interim basis and could ultimately serve as the final PLRGs for some sub-basins. The provisional PLRGs assigned to these sub-basins are conservative (based on estimated c. 1943 loading rates) and are used as planning targets in lieu of or until final PLRGs are established. Provisional PLRGs, or "allowable" loading rates, for these sub-basins can be reviewed in the preceding section under *Sub-basin Water Management Plans (Central IRL).*

*Non-point Source Strategy – Muck***.** The Central IRL is the focus area for muck removal projects just as it is for the large, regional surface water management programs described above.

The SJRWMD will be working to accelerate the USACE's schedule to maintenance dredge the Intracoastal Waterway (ICW) from the Haulover Canal-Titusville reach southward through Brevard County and into Indian River County. Other major deposits of muck, lying outside the ICW channel (e.g., lesser navigational channels, causeway borrow areas, other dredge holes), could also be dredged during the ICW maintenance dredge operation. The funding and logistics for such an expanded operation will be a matter of discussion with the USACE in 2002/03.

Meanwhile, the SJRWMD and its consultants are completing a plan to dredge muck from the lower reach of Sebastian River and could develop a similar plan for Eau Gallie River within the next 3 to 5 years (possibly, with USACE assistance). It is difficult to establish a start-date on the dredge project in Sebastian River because the planning is not completed nor has the project been permitted. Based on current progress and funding commitments, the dredging in Sebastian River could begin in the River's lower reach in late 2003 immediately following a pre-dredge environmental survey. With respect to Eau Gallie River, it may be several years (2005 at the earliest) before a dredge operation could commence.

Post-dredge evaluations may be completed for Crane Creek and Turkey Creek by 2003 and 2005, respectively. These evaluations seek to improve the engineering and operational efficacy of future dredge projects and to reveal what can truly be environmentally achieved. It is clear that soil erosion and sediment control measures

are lacking in watersheds where enormous accumulations of muck and sand have occurred. In fact, preliminary data on Crane Creek, where no erosion control program is currently in place, suggests fairly rapid infilling of newly dredged areas within months following dredge operations. Whether this recent deposition is largely bed-load material from non-dredged areas or newly eroded material washing into the creek is difficult to identify at this time (likely it's both, but more of the former so far). Nonetheless, this rapid infilling does point out the importance of implementing controls to prevent or minimize erosion and sediment transport.

Consideration should be given to developing a long-range plan, covering the next 15 to 20 years, for the removal of major muck deposits at all priority sites throughout the IRL basin (10 major sites, including southern Banana River Lagoon). The plan would include the method and results of the site prioritization, an estimated permit and dredge schedule for each project site along with general budget information, and a source control strategy that would be implemented prior to or contemporaneous with muck removal.

Non-point Source Strategy – Septic Tanks (a.k.a. OSDS). Local policy and ordinances restricting OSDS installations coupled with state and/or federal funding incentives could effectively resolve this non-point source problem. OSDS areas that are deemed a potential problem are located in southern Brevard County, the South Prong sub-basin of the Sebastian River, and southeastern Indian River County. Although there has been no definitive link established between OSDS and nutrient enrichment or bacteriological contamination of the IRL, studies have revealed that the *potential* for such cause and effect certainly exists, particularly in localized, high-density OSDS areas (Ayres Associates, 1993; Horsley and Witten, Inc., 2000). To promote protection of the IRL resources and the surficial aquifer, and to further reduce health risks associated with pathogen release, a change from OSDS use to centralized or regional wastewater collection and treatment is encouraged. Additionally, state and/or federal programs could improve financial support for local government projects providing central sewer to OSDS areas.

Recently a cost/benefit analysis of various alternatives for wastewater treatment and disposal was conducted for the IRLNEP. A cost/benefit model was developed and a variety of wastewater treatment/disposal alternatives were analyzed (ranging from OSDS to regional wastewater facilities). Using actual cost data from the IRL region, it was concluded that large-scale centralization of wastewater treatment (e.g., large WWTPS that serve regional areas) provides better treatment at a lower cost that OSDS or small-scale facilities (a.k.a. "package plants") (Horsley and Witten, Inc., 2001). It is anticipated that local governments will be able to use this analysis to estimate the costs and benefits of providing centralized sewer to both new development and OSDS areas.

Point Source Strategy – Domestic Wastewater Treatment Plants. Domestic WWTPs appear to be a very minor source of pollution thanks to local government action in response to the IRL Act (Chapter 90-262, Laws of Florida). However, the Act does allow WWTPs to discharge during wet weather. Therefore, the next step is to employ practical and environmentally sound solutions that will enable further reductions in wet weather effluent discharges to the IRL system.

Industrial WWTPs are permitted and monitored by FDEP (see Appendix B.2 for list of facilities) and are found to pose no apparent threat to the IRL (M. Paulic, personal

communication, 10/17/02, based on a statement from FDEP's Central District office). However, reverse osmosis (RO) water treatment plants were a target of investigation and debate a few years ago because of concerns about the quality of their effluent discharge to the IRL (VanHems, 1999). Even though RO effluent is considered a brine discharge, it may be fresher than most reaches of the IRL. This and other potential contaminant concerns have placed RO plants under regulatory scrutiny by the SJRWMD pursuant to its authority to issue water supply permits (a.k.a. consumptive use permits). The SJRWMD is hopeful that this scrutiny may, in effect, induce further improvements in RO effluent treatment technology.

Monitoring, Modeling, and Applied Studies. The SJRWMD and its partner agencies will continue the seagrass and water quality monitoring networks described in Chapter 2 (pp. 2-15 and 2-16). The SJRWMD will continue to seek improvements to the monitoring networks with respect to operational efficiency and informational veracity. Analyses and reporting of monitoring data will key in on salinity trends and those major optical pollutants that may be significant in the North and Central IRL: TSS, color, and phytoplankton (as indicated by chlorophyll *a* concentrations).

The dual role of drift macroalgae (e.g., *Gracillaria* spp.) and attached macroalga (*Caulerpa prolifera*) as a habitat resource and as a mediator of nutrient loads may be quite important in the North IRL and in the northern reach of the Central IRL where flushing is relatively sluggish. This resource should be further explored with respect to its abundance distribution (spatially and seasonally) and nutrient management potential.

It's been over 10 years since the Lagoon-wide muck and toxic substances survey was conducted (Trefry et al. 1990; Trefry and Trocine, 1993; Windsor and Surma, 1993). This survey should be repeated to provide a more current assessment of these aspects of environmental pollution. Furthermore, site-specific surveys of muck distribution, volume, and characteristics (physical and chemical) will be conducted as planning requirements for any future muck dredge operations. Presently, such operations are being planned for the lower reach of Sebastian River and may be planned for Eau Gallie River. Post-dredge surveys will be completed for Crane and Turkey Creeks over the next 4 to 5 years. Post-dredge analysis should help in the far-range development of the muck management program.

By 2003, the PLR Model should be verified and ready to be applied toward the development of final PLRGs in the IRL. In the meantime, provisional pollutant load reduction targets can be used in stormwater treatment designs (see Tables 5-4 and 5-5). These provisional targets are intended to be conservative and, thus, be used to design municipal or regional stormwater treatment systems that should be able to meet the final PLRGs. The SJRWMD will use the PLR Model to "test" the adequacy of the provisional targets. If they are determined to be too stringent, the targets may need to be relaxed or re-set at levels that are more economically achievable but can still meet the water quality/light requirements for seagrass restoration.

Land Acquisition. Land acquisition serves as both a resource protection strategy and as a prerequisite for water quality restoration since lands are needed to construct surface water treatment basins. Thousands of acres will be needed, mostly in the Central IRL, for surface water storage and treatment. Much of this land has been purchased for the C-1 re-diversion project in the Turkey Creek sub-basin and for the stormwater master plan of the City of Sebastian. Hundreds of additional acres will need

to be acquired to satisfy similar project objectives elsewhere in Crane Creek, Turkey Creek (Malabar and Palm Bay), Sebastian River, and the Indian River Farms WCD sub-basins. Because of the magnitude and importance of non-point source control in the Central IRL, more effort will be spent toward acquiring land there over the next 5 years than in the other sub-lagoons in the SJRWMD, except the South IRL and St. Lucie River sub-basin[27].

For information on wetland acquisition and other lands for the sake of habitat restoration or preservation, refer to the Coastal Wetlands section below (and in the other chapters).

Coordination with Other Agency Plans. The SJRWMD is engaged with a few federal agencies in the planning of management initiatives that will build upon the current projects in the North and Central IRL. The lead federal agencies and management initiatives are:

U.S. Army Corps of Engineers (USACE) – IRL- North Feasibility Study. This study covers both the North and Central IRL. Its purpose is to develop strong justifications for large expenditures of federal and local cost-share monies in support of major restoration activities such as wetland restoration, muck dredging projects, watershed erosion control programs and other surface water management BMPs, and possible causeway modifications to improve flushing and water quality.

U.S. Fish and Wildlife Service/Merritt Island National Wildlife Refuge (USFWS/MINWR) – MINWR Comprehensive Conservation Plan. Because this plan will affect management, land use, and public use activities in the MINWR for 15 years or more before it is re-visited, it is important for the SJRWMD and IRLNEP to be involved in its development. This plan can have a major, positive impact on the water quality, seagrasses, and fisheries in the open estuary of the North IRL and the southern reach of Mosquito Lagoon (as well as on the wetlands on Merritt Island).

NASA – Space Act Agreement with the SJRWMD. This agreement enables NASA funding and participation in a range of monitoring, data management, and information dissemination activities that will ultimately benefit all resource management agencies and the general public. Additionally, NASA's mitigation plan for proposed development in and near Cape Canaveral is anticipated to be final soon. The SJRWMD will review this plan with an eye toward incorporation of water quality improvement measures as well as wetland restoration projects.

Equally as important as the federal initiatives described above are those municipal and county plans aimed at reductions and treatment of surface water drainage. It is hoped that local governments, especially those that have management authority in the priority sub-basins of the Central IRL (Crane and Turkey Creeks, Sebastian River, and the Indian River Farms WCD/Vero Beach), will complete their plans within a year or two and that this is followed by aggressive implementation of projects over the next 5 years and beyond. Toward that end, the SJRWMD can assist local governments with technical guidance, direct funding support, and by applying for other sources of funds.

[27] Major land areas (tens of thousands of acres) needed for storage and treatment of surface waters were identified in the South IRL and St. Lucie River sub-basin by the SFWMD and USACE during the feasibility study of the South IRL (refer to chapters 6 and 7 for details on that program).

Table 5-7. The 5-Year Plan List of Seagrass and Water Quality Projects for the North and Central IRL

- **Continue monitoring in the North and Central IRL as part of the Lagoon-wide monitoring networks***
  - **Water Quality Monitoring (NASA, SJRWMD, Indian River County)**
  - **Seagrass Mapping and Field Monitoring**
  - **Meteorological Monitoring**
  - **Hydrodynamic Monitoring**
- **Initiate regular monitoring of drift macroalgae and investigate its habitat and nutrient management value**
- **Develop final PLRGs by end of 2004**
- **Implement non-point, surface water projects aimed at reduction of nutrient, TSS, and freshwater inputs (in cooperation with Brevard County, Indian River County, Titusville, Cocoa, Rockledge, Melbourne, Indialantic, Palm Bay, Malabar, Sebastian, Roseland, Vero Beach, and the Water Control Districts)**
- **Recommend inclusion of large-scale regional stormwater projects within the Capital Improvement elements of the comprehensive growth plans of Brevard and Indian River counties**
- **Conduct the 5-year *IRL-North Feasibility Study* (USACE and SJRWMD)**
- **Conduct the Sebastian River muck removal project**
- **Develop 10-year plan for removal/management of muck from other priority areas**
- **Conduct re-survey of IRL for toxic substances (with emphasis on muck deposition areas)**
- **Continue periodic inventory of domestic WWTPs**
- **Continue to support actions by the counties in any further remediation of septic tank areas**
- **Pursue acquisition of lands identified under the *Blueway* program**

* **Descriptions of monitoring networks are found in Chapter 2, and listed in Table 2-4.**

Coastal Wetlands

Substantial progress has been made over the last 10 years in reconnecting impounded wetlands in the North and Central IRL. Over 16,400 acres of the 23,086 acres of total impounded wetlands in the North and Central IRL have been reconnected since 1991 (Figure 5-12 and 5-13). However, in just the last three years, the SJRWMD has been dealing with mitigation, management, and ownership issues that have stalled reconnection efforts on the remaining impoundments.

In the North IRL, mitigation planning is the immediate issue, specifically in the Merritt Island National Wildlife Refuge (MINWR), that has temporarily halted further reconnection efforts. Over 50% of the Lagoon's wetlands exist in the MINWR as do most of the remaining isolated impoundments. NASA is the landowner and is in the midst of developing a regulatory mitigation plan for MINWR in response to its projected expansion of facilities. This expansion will cause some environmental impacts, which is the reason for the mitigation plan. NASA and the SJRWMD are working together to identify appropriate mitigation projects by NASA, and impoundment reconnections would

Figure 5-12. North Indian River Lagoon Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.

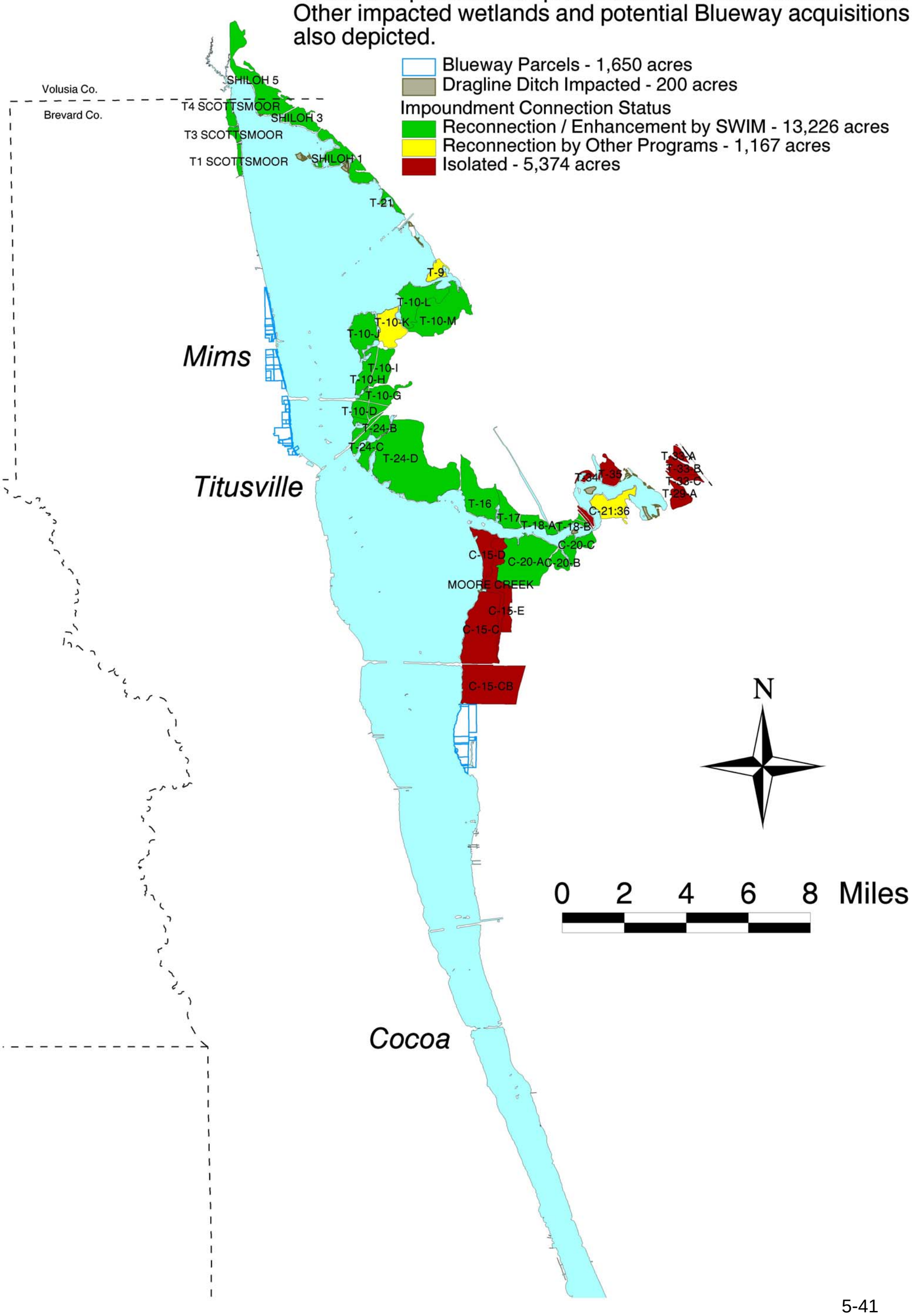

Figure 5-13. Central Indian River Lagoon Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.